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RECLAIMING OF DETERIORATED SPECIFICATION MIL-L-7808
AIRCRAFT GAS TURBINE OILS

by

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ABSTRACT

Samples representative of 35,000 gallons of MIL-L-7808 oil which had deteriorated during storage were examined. All contained insoluble matter and two were corrosive to lead. Methods of reclaiming these oils with adsorbents were investigated; only a chromatographic grade alumina efficiently removed the lead-corrosive component. The antioxidant and antifoam agents were not removed by this process, since the treated oil successfully passed the pertinent tests.

It is estimated the deteriorated oil may be reclaimed for approximately 20 percent of its current replacement cost. This figure is based on materials cost and losses during processing; it does not include handling and packaging charges. A treatment process is recommended.

PROBLEM STATUS

This is an interim report; work on the problem is continuing.

AUTHORIZATION

NRL Problem No. C02-01

BUAER Problem No. PP-0405

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INTRODUCTION

A major problem associated with Specification MIL-L-7808 lubricants (1) has been poor long-term storage stability. The most frequent manifestations of this phenomenon are color changes, development of insoluble materials, rusting of interior container walls, and onset of lead corrosivity. It has been established that this corrosivity to lead is not an inherent property of the MIL-L-7808 formulation, but rather is a result of the formation of a half ester (2). Impurities associated with the customary antiwear agent tricresyl phosphate are believed to promote formation of the half ester. Unpublished data from other laboratories have indicated that more careful quality control of the additive, or its replacement, would greatly increase the storage stability of the oil.

This activity was informed by the Bureau of Aeronautics that approximately 35,000 gallons of MIL-L-7808 oil had deteriorated in storage. The oil had been procured from three qualified suppliers and had been in storage for periods of up to two years. At a conference held in September 1956, BUAER requested that this activity examine the subject oils to determine their condition. In the event that they had deteriorated, it was further requested that the feasibility of reclaiming the oils be explored.

In accordance with the above directive, three 5-gallon containers of MIL-L-7808 oil were shipped by the Norfolk Naval Base to this Laboratory in October 1956. There was one sample from each of the three suppliers. The oils were identified as follows:

Lubricating Oil, Aircraft, Gas Turbine Engine
MIL-L-7808B AM-1 WS 9150-227-0184
American Oil and Supply Co. Newark, N. J.
7/55 ASP 12312 15 3R and H Co. Ws. 43.7

Lubricating Oil, Aircraft, Jet Engine
MIL-L-7808B
Esso Std. Oil Co. Linden, N. J.
12/54 ASP-10604 50

Lubricating Oil, Aircraft, Jet Engine
MIL-L-7808B Penola Oil Co. Linden, N. J.
12/54 ASP-10657 47

For convenience, the American Oil and Supply Company oil will be referred to as Oil "A", and those of the Esso Standard Oil Company and the Penola Oil Company as Oils "E" and "P" respectively.

- (1) Specification MIL-L-7808C "Lubricating Oil, Aircraft Turbine Engine, Synthetic Base"
- (2) WADC Report "Study of High Lead Corrosion", G. A. Beane, 23 February 1956

LABORATORY EXAMINATION OF OILS

Oil "A" was clear and light amber in color, but contained a small quantity of a finely divided black sediment. The vertical inner seam of the uncoated steel container was slightly corroded. Oil "E" was dark red-brown and contained a moderate quantity of fine dark insoluble material. The color of Oil "P" was also dark red-brown, but it contained a greater quantity of insoluble material than did Oil "E". The interiors of the containers of both Oils "E" and "P" were badly corroded.

A portion of each oil was filtered through a fritted glass funnel. In every instance the insolubles were comprised of an organic and an inorganic component, since upon ignition on platinum foil, the material burned leaving a reddish residue. The nature of the latter strongly suggested iron oxide which probably owed its presence to corrosion of the containers by a slight amount of dissolved water. It will be recalled, in this connection, that MIL-L-7808 oils do not contain a rust inhibitor.

Oils "A", "E", and "P" conformed to the requirements of Specification MIL-L-7808C as regards viscosity, ASTM evaporation loss, pour point, and low-temperature storage stability, Figure 1. The neutralization numbers of Oils "A", "E", and "P" were 0.40, 0.24, and 0.20 respectively. Oil "A" was the only fluid tested for its tendency to foam; it conformed to the specification requirement. All oils passed the specification (1) corrosion and oxidation stability test, Figure 2. None of the oils were corrosive to copper and silver under the specified test conditions (1), since the maximum weight loss was only 0.6 mg/in². The specification permits a weight loss of up to 3.0 mg.

Lead corrosivity was determined according to the S.O.D. lead corrosion test of Specification MIL-L-7808C; results are shown in Figure 3. The specification permits a lead weight loss of 6 mg/in². Oil "A", with an S.O.D. corrosion number of 61, was the most corrosive; Oil "P", with a corrosion number of less than 0.1 mg/in², was the least corrosive. Although the lead corrosivity of Oil "E", 3.7 mg/in², was within specification limits, previous data from WADC (2) have indicated that such a value usually connotes an actively deteriorating oil. This was confirmed by repeating the S.O.D. corrosion tests on the subject oils 60 days after their arrival at this laboratory. The corrosion number of Oil "E" had increased from 3.7 to 5.2 mg/in², barely conforming to the specification requirement. Oils "A" and "P" showed less significant changes. At the present time, therefore, Oil "P" remains the only one to be essentially noncorrosive to lead.

EXPERIMENTS ON RECLAIMING CORROSIVE OILS

Experience at this Laboratory has demonstrated the effectiveness of a variety of solid adsorbents to remove minor concentrations of polar impurities from organic liquids. The most useful of these materials have been silica gel,

fuller's earth, aluminum oxide, and Florisil. Silica gel is not recommended for alkyl esters because of the possibility of promoting decomposition. In general, Florisil is not as effective for the purification of alkyl esters as are fuller's earth and alumina. The half ester, believed to be the corrosive component in deteriorated MIL-L-7808 oils (2), is of a type usually selectively adsorbed by fuller's earth, alumina, and Florisil. A qualitative preliminary investigation confirmed the value of the adsorption technique for reclaiming deteriorated MIL-L-7808 oils (3).

To conserve the test fluids, their corrosivities to lead were determined by a static test which required only 60 ml of oil, rather than the 500 ml required by the S.O.D. procedure (1). The static test (3) consisted of suspending copper and lead specimens in the unstirred test oil for seven and one-half hours at 163°C, and then determining the extent of lead loss.

It had been determined earlier that Florisil was not particularly effective in reducing the lead corrosivity of a deteriorated MIL-L-7808 oil (3). Attention was therefore directed, in the present investigation, towards fuller's earth and alumina. Oil "A", the most corrosive of the subject oils, was used as the reference fluid. The fuller's earth was a commercial grade, produced by the Attapulugus Clay Company, and designated "Grade A, Low in Volatile Matter, 60 to 90 mesh". The alumina was produced by the Aluminum Company of America, and designated "Chromatographic Grade F-20, 80 to 200 mesh". Both adsorbents had been stored for many years in the laboratory in loosely closed containers from which no provision had been made to exclude moisture. Before use, therefore, these materials were activated at 260°C for three hours, and then stored at 190°C. Two-3/4 inch I. D. glass chromatographic columns were assembled, each containing 10 g of adsorbent. Since the fuller's earth was less dense than was the alumina, its height in the column was approximately twice that of the latter material. Sufficient oil was continually passed through the columns to assure depletion of adsorption ability. Percolate fractions were collected at intervals, and their corrosiveness determined by the static test. Results are shown in Figure 4.

The original static corrosion loss of Oil "A" was 7.4 mg/in². The first 130 ml to pass through the alumina were noncorrosive. The fraction from 130 to 350 ml exhibited slight corrosivity, 0.4 mg/in². The final fraction, 350 to 415 ml, was as corrosive as was the original oil. Fuller's earth proved to be less effective than was alumina. Although the first 130 ml fraction was noncorrosive, the following 65 ml caused a lead loss of 0.8 mg/in²; the final 65 ml fraction, 195 to 260 ml, approached the original oil in corrosivity. The percolate from the treatment with fuller's earth was considerably lighter in color than was the original oil, while the adsorbent itself assumed various hues of red, green, and blue. This discoloration of the fuller's earth indicated at least a partial removal of the antioxidant, probably phenothiazine. The percolate from the alumina treatment, on the other hand, had about the same color density as the original fluid, and the alumina was only slightly darkened, indicating that little if any inhibitor was removed. Another conclusion to be drawn from these experiments was that

under the stated conditions, the transition period between complete and incomplete removal of the corrosive component was relatively short.

In practice, petroleum fractions having viscosities of the same order as MIL-L-7808-type oils are generally treated with adsorbents by a contact rather than a percolation process. To obtain intimate contact between the liquid and the adsorbent in the contact process, mechanical or air agitation is employed. The spent solid adsorbent is removed by filtration. Based on the above, a laboratory contact procedure was devised to treat the corrosive oils. Two g of either alumina or of fuller's earth, activated as described, were added to separate 100 ml portions of Oil "A". To compare the efficacy of a strongly basic material with those of the other adsorbents, a third 100 ml portion of Oil "A" was treated with two g of analytical grade anhydrous sodium carbonate. The three samples were gravity-filtered through a fritted glass funnel, using Celite as a filtering aid. Results are shown in Figure 4.

With the use of alumina, the static corrosion number decreased from 7.4 to 0.2 mg/in²; with fuller's earth, the static corrosion number was 5.8 mg/in². The sodium carbonate treatment appeared to be completely ineffective since the treated oil was as corrosive as was the original, despite the large decrease in neutralization number. Of the materials examined, then, alumina was the most effective, confirming the results obtained with the percolation procedure. The minimum quantity of alumina necessary for successful treatment of the oil appeared to be of the order of 2 g to 100 ml (1 to 45 by weight).

On the basis of these promising results, sufficient oil for a standard S.O.D. test was treated with alumina according to the above procedure, i.e., intimate mixing for 16 hours followed by filtration. Two 700-ml samples of Oil "A" were treated respectively with 21 and 63 g of alumina, 3 and 10 percent on a weight basis. Results are shown in Figure 3. After treatment with the smaller alumina-oil ratio, the S.O.D. corrosion number had decreased from 61 to 6 mg/in². With the 1 to 10 alumina-oil ratio, the S.O.D. corrosion number decreased to only 0.1 mg/in². Use of this higher alumina to oil ratio appeared desirable to ensure complete removal of the corrosive component. Recovery of oil under the latter conditions was approximately 90 percent; use of pressure or suction during filtration would probably increase the yield to about 95 percent.

In an attempt to simplify the procedure, the alumina was not reactivated, but used as stored, and contact time reduced to three hours. By employing this procedure the S.O.D. corrosion number of Oil "A" was reduced to 0.2 mg/in², the alumina to oil ratio again being 1 to 10, Figure 3. It is evident, therefore, that Alcoa chromatographic alumina F-20 may be employed as received from the manufacturer, and that contact time with the oil need not be for more than a few hours duration, provided intimate mixing is obtained.

While alumina in sufficient quantity was patently effective in removing the lead corrosivity of Oil "A", the possibility remained that additives, particularly the antioxidant and the antifoam agent, were likewise removed by this treatment. To investigate the first of these contingencies, a portion of the filtrate from an alumina-oil slurry (alumina 10 percent by weight,

activated at 260°C, contact time 16 hours) was subjected to the Specification MIL-L-7808 corrosion-oxidation test. As shown in Figure 2, the oil conformed to the requirements of the specification in every particular, and appeared to be at least as stable as was the original fluid. This confirmed the conclusion reached after the percolation experiments, i.e., alumina did not adsorb the oxidation inhibitor. As regards the second contingency, the treated oil displayed no greater tendency to foam than it did before the contact procedure, Figure 1.

Having demonstrated that chromatographic alumina could remove the lead-corrosive component of Oil "A" without serious depletion of the oxidation inhibitor and antifoam agent, it was of interest to determine whether an even more deteriorated oil could be similarly reclaimed. The properties of such an oil (4), Coded Oil "W", are shown in Figures 1 and 3. Its neutralization number was significantly large, 2.98, and its S.O.D. lead corrosion number was 230 mg/in². When subjected to the specification corrosion-oxidation test, the magnesium and copper specimens each lost approximately 5 mg/cm², and the viscosity increase of 14.7 cs at 100°F was barely within the specification limit, Figure 2.

Three 700-ml portions of Oil "W" were contacted with 3, 10, and 30 weight percent of activated alumina, and then filtered. The results of S.O.D. corrosion tests on the filtrates, Figure 3, indicated that the smallest concentration of alumina had essentially no effect on corrosivity, 10 percent of alumina decreased the lead corrosivity by a factor of 2, and 30 percent of alumina resulted in complete removal of the corrosive component. That more alumina was required to treat Oil "W" than Oil "A" is understandable in view of the greater corrosivity of the former.

The corrosion-oxidation stability of Oil "W" was determined after treatment with activated alumina (30 weight percent). Although the original fluid had not been stable, it now conformed to the specification requirements, Figure 2. At the conclusion of the 72 hour test period, the neutralization number was 0.8 (as compared to 3.0 before treatment with alumina), the viscosity change was one percent at 100°F, and metal catalyst weight losses were all less than 0.1 mg/cm². It is probable this unanticipated improvement in oxidation stability was a consequence of the reduction of oil acidity by the alumina treatment. Contacting MIL-L-7808 oil with as much as 30 percent alumina evidently removed little, if any, more of the oxidation inhibitor than did 10 percent.

The chromatographic alumina employed in the previous experiments is relatively expensive. It was therefore of interest to determine whether less costly alumina would be equally efficacious for reclaiming the subject oils. Accordingly, two technical grades of alumina were first examined, they were identified as follows:

Aluminum Company of America
Technical Alumina A-14

and

Fisher Laboratory Chemical
Aluminum Oxide, Anhydrous, Technical

(4) NRL ltr rpt 6170-56A/56 mew of 8 Feb 1956 "Laboratory Examination of WADC Oil Coded B/2 AF 60899 St No. 56-217314".

In 10 weight percent concentration, each of these materials was contacted with separate portions of Oil "A" for 16 hours, and then filtered. S.O.D. corrosion numbers on the oils treated with the Alcoa and the Fisher aluminas were 47 and 68 respectively, Figure 3. Activation of the aluminas at 260°F resulted in even larger corrosion numbers.

Two reagent grade aluminas were next tested for their ability to remove the corrosive component of Oil "A". They were identified as follows:

Fisher's Certified Reagent
Aluminum Oxide, Anhydrous

and

Aluminum Oxide, C.P.
Ignited Powder
General Chemical Company Baker and Adamson Quality.

After treatment with the Fisher alumina as received, the corrosion number of Oil "A" decreased from 61 to 38 mg/in², Figure 3. Activation of the alumina had no beneficial effect. On the other hand, the General Chemical Company alumina appeared to be as efficacious as was the Alcoa chromatographic grade. Using only three weight percent of the former, the S.O.D. corrosion number of Oil "A" decreased to 1.5 mg/in² after 16 hours contact time. Increasing the quantity of alumina to ten weight percent resulted in an even smaller value, 0.6 mg/in².

The discrepancy between the results obtained with the reagent grade aluminas is not understood. The General Chemical Company material was quite old, probably predating World War II. It is very possible the alumina was actually a chromatographic grade, but it was not feasible to trace its history. On the basis of the results obtained in this investigation, it does not appear that grades of alumina other than chromatographic are suitable for reclaiming corrosive MIL-L-7808 oils.

COST OF MATERIALS ESTIMATE

In the present study, the only alumina studied which was definitely ascertained to be a chromatographic grade was Alcoa F-20. This material was therefore used as the basis of a cost estimate to reclaim the subject oils. Although the three oils differ in corrosivity, the relative quantity on hand from each manufacturer is not known. Cost estimates were therefore based on the reclaiming of Oil "A", the most corrosive of those examined. Assuming that all of the oil (35,000 gallons or 267,000 pounds) is to be reclaimed, 26,700 pounds of alumina would be required, using a one to ten proportion by weight of alumina to oil. The present price of Alcoa F-20 alumina in lots of 10,000 to 40,000 pounds, in waterproof 100 pound paper bags, is 85 cents per pound, f.o.b. St. Louis, Missouri. In 325 pound steel drums, the cost is 86 cents per pound. Shipping charges to the east coast are estimated at two cents per pound. Thus the cost of the delivered material would be either \$23,200 or \$23,500 depending upon the shipping containers. For purposes of this estimate, the delivered alumina will be assumed to cost \$23,400.

With a minimum oil recovery of 95 percent, the processing of 35,000 gallons would yield 33,250 gallons, a loss of 1750 gallons. Assuming a price

of \$5.00 per gallon for MIL-L-7808 oil, the present replacement cost of the corrosive oil is \$175,000. The 1750 gallon loss sustained during processing represents \$8750. When the cost of the alumina, \$23,400, is added to that of the oil lost during treatment, the total, \$32,150, represents the cost of reclaiming the oil, exclusive of handling and packaging charges. The latter charges have not been included in this report since insufficient information is available to make a realistic estimate.

DISCUSSION

The present investigation has demonstrated that, for a moderate expenditure for materials, lead-corrosive MIL-L-7808 oils from the American Oil and Supply Company, and the Esso Standard Oil Company may be rendered noncorrosive and usable. Although the Penola Oil Company fluid is now noncorrosive, it is contaminated with particles of rust and other insoluble matter. Since this oil would in any event require filtration and repackaging, it would appear advisable that it also be treated with alumina to forestall the possible development of lead corrosivity. The Esso and Penola oils might require less alumina for their treatment than does the American Oil and Supply fluid, but this would require confirmation by laboratory tests.

There is at present no known reliable method for predicting the storage stability of MIL-L-7808 oils as regards lead corrosivity. While there is every reason to assume that treatment of the subject oils as described will render them at least as stable in this respect as are newly formulated oils, it is nevertheless true that there are no data to substantiate this belief. It would therefore be advisable to use the processed oils within a reasonable period after packaging, say six months.

Although nominally compatible, the subject oils may contain either different additives or the same additives from different sources. To forestall any possible interaction, it may be advisable to process and package the oils separately. It is possible that treatment of these oils removes not only the corrosive component but also the agent which promotes its formation. Therefore, a portion of each processed oil should be set aside to follow its storage stability.

SUMMARY AND CONCLUSIONS

Samples of MIL-L-7808 oils from the American Oil and Supply Company, the Esso Standard Oil Company, and the Penola Oil Company, coded oils "A", "E", and "P" respectively, were examined. These oils, said to be unusable, were representative of 35,000 gallons packaged in 5-gallon steel drums. All container interiors were corroded to varying degrees, particularly at the seams, and the oils contained some sediment and suspended matter. The fluids conformed to Specification MIL-L-7808 as regards viscosity, pour point, storage stability, copper and silver corrosion, ASTM evaporation loss at 400°F, and corrosion-oxidation stability. Oil "A" was highly corrosive to lead, but Oil "P" was satisfactory in this respect. The lead corrosivity of Oil "E" became marginal during the period covered by the investigation.

Exploratory work with adsorbents, utilizing both percolation and contact processes, indicated the feasibility of reclaiming the most corrosive of the fluids, Oil "A". The most efficient of the adsorbents investigated was Alcoa chromatographic grade alumina F-20. Currently available grades of alumina less expensive than chromatographic did not reduce the corrosivity of Oil "A", even after their activation. An older sample of reagent grade alumina did reduce corrosivity, but its history and current availability are not known. Fuller's earth was not only less effective than was chromatographic alumina, but it also removed an undetermined quantity of the oxidation inhibitor.

The experimental method developed for treatment of the corrosive oil was to contact it with one tenth its weight of chromatographic alumina for three hours, followed by filtration. It did not appear necessary to activate the alumina. Oil "A", treated in this manner, was noncorrosive to lead under the conditions of the S.O.D. test. It conformed to both the corrosion-oxidation stability and the defoaming requirements of Specification MIL-L-7808, indicating the pertinent additives required no replenishment. These results were confirmed by similarly treating a highly corrosive and oxidation-unstable oil with 30 weight percent of chromatographic alumina. The treated oil was both oxidation-stable and noncorrosive to lead.

Based on current material prices, \$23,400 worth of alumina will treat 35,000 gallons of MIL-L-7808 oil whose replacement cost is approximately \$175,000. Since recovery is estimated at 95 percent, \$8,750 worth of oil would be lost during processing, bringing total costs to \$32,150 exclusive of handling and packaging charges. Oils "E" and "F" might require less alumina than that recommended for Oil "A", resulting in lower material costs. The optimum quantity required for the former oils could be determined by laboratory tests.

To forestall possible interaction of additives, the oils from different sources should be processed and packaged separately. In addition to removing the corrosive component, treatment with alumina may possibly remove the agent responsible for its formation. This could best be determined by following the storage stability of the treated oils.

RECOMMENDATIONS

If it be decided to reclaim the subject oils, it is recommended that:

- a. Alcoa chromatographic alumina F-20, or its equivalent, be employed as the adsorbent, according to the procedure outlined in Appendix 1.
- b. The efficacy of the alumina chosen be verified by laboratory tests before use.
- c. The subject oils be treated and packaged individually. Before packaging, however, each batch should be tested for corrosion-oxidation stability and lead corrosivity.

- d. The oils be used within a reasonable period after treatment.
- e. Samples of the treated oils be set aside for storage stability studies.

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APPENDIX 1

PROCEDURE FOR RECLAIMING CORROSIVE OILS

The procedure for reclaiming lead-corrosive oil that has been outlined in this report is such that it may conveniently be employed in conventional plant equipment. Assuming that a batch contact process is used, one part of a suitable alumina equivalent to Alcoa chromatographic grade F-20, is added to 10 parts by weight of oil. Somewhat less alumina might be required for Oils "E" and "P", but this should be verified by laboratory tests. It is important that the alumina be stored in a dry location before use. The slurry should be agitated thoroughly, preferably by mechanical stirring, for a minimum of three hours. The slurry is then filtered by any conventional method which would assure that no fines pass into the filtrate. Celite or other aids may be employed to expedite filtration. With the use of either pressure or suction during filtration, about 95 percent recovery of the original oil would be anticipated.

If a percolation procedure is preferred to the contact process described, it may be substituted for the latter. However, the ratio of alumina to oil must be maintained as before, i.e., one to ten on a weight basis, at least as regards Oil "A". As with the contact process, somewhat less alumina may be required for the other oils.

Figure 1

Physical and Chemical Properties of MIL-L-7808 Oils "As received"

	Viscosity $\frac{\text{cP}}{\text{1000}}$		Evaporation Loss at 400°F for 6-1/2 hrs.		Pour Point 4 hrs. at -75°F	Storage 72 hrs. at -65°F	Neut. No.	Foaming Test
	2100	1000	-650					
Oil "A"	3.34	13.07	10,125	15.2%	pours	pours	0.40	pass*
Oil "E"	3.61	14.26	12,130	15.4%	pours	pours	0.24	
Oil "P"	3.52	13.92	11,990	15.1%	pours	pours	0.20	
Oil "W"	3.54	14.41	10,160	13.7%	pours	pours	2.98	
Specification MIL-L-7808C	3.0 min.	11.0 min.	13,000 max	25%	pours	pours	No requirement **	

Oil "A" supplied by the American Oil and Supply Co. of Newark, N. J.

Oil "E" supplied by the Esso Standard Oil Co. of Linden, N. J.

Oil "P" supplied by the Penola Oil Company of Linden, N. J.

Oil "W" from WADC used for comparison, it was in an advanced state of deterioration

* -- Both the "as received" oil and the filtrate from later treatment with alumina conformed to this requirement.

** - Sequences 1, 2, and 3 as described.

Figure 2

Results of Corrosion-Oxidation Test 347°F for 72 hrs.

MIL-L-7808		Oil "A" as rec'd.	Oil "E" as rec'd.	Oil "P" as rec'd.	Oil "A"*	Oil "W" as rec'd.	Oil "W"***
Specification							
Evaporation %	8.0	1.4	2.0	1.4	1.0	2.7	2.0
Metal Catalysts							
mg/cm ² change							
copper	<0.4	<0.1	+0.10	<0.1	<0.1	-4.54	<0.1
steel	<0.2	<0.1	<0.1	+0.11	<0.1	<0.1	<0.1
silver	<0.2	<0.1	+0.18	+0.18	<0.1	<0.1	<0.1
magnesium	<0.2	<0.1	<0.1	+0.12	<0.1	-5.06	<0.1
aluminum	<0.2	<0.1	+0.11	+0.13	<0.1	<0.1	<0.1
Viscosity Increase % at 100°F	-5 to +15	+4	+4	+3	+3.4	+14.7	-1.1
Neut. No. Increase	2.0	1.00	0.69	0.58	1.10	-0.90	0.79

* -- treated with 10% chromatographic Al₂O₃ (activated)

** -- treated with 30% chromatographic Al₂O₃ (activated)

Figure 3

Effect of Adsorbents on S.O.D. Lead Corrosivity

Fluid	Treatment	Lead Loss, mg/in ²
Specification MIL-L-7808C requirement		6.0 (max)
Oil "A"	As received	61.
Oil "E"	As received	3.7
Oil "P"	As received	<0.1
Oil "A"	60 days storage at NRL	69.
Oil "E"	60 days storage at NRL	5.2
Oil "P"	60 days storage at NRL	0.8
Oil "A"	Agitation for 16 hrs with 3 wt % Alcoa F-20 alumina (activated at 260°C)	6.8
Oil "A"	Agitation for 16 hrs with 10 wt % Alcoa F-20 alumina (activated at 260°C)	0.1
Oil "A"	Agitation for 3 hrs with 10 wt % Alcoa F-20 alumina (as received)	0.2
Oil "W"	As received	230.
Oil "W"	Agitation for 16 hrs with 3 wt % Alcoa F-20 alumina (activated at 260°C)	213.
Oil "W"	Agitation for 16 hrs with 10 wt % Alcoa F-20 alumina (activated at 260°C)	113.
Oil "W"	Agitation for 16 hrs with 30 wt % Alcoa F-20 alumina (activated at 260°C)	0.2
Oil "A"	Agitated for 3 hrs with 10 wt % Fisher technical alumina (as received)	17
Oil "A"	Agitated for 3 hrs with 10 wt % Fisher technical alumina (activated at 260°C)	58
Oil "A"	Agitated for 3 hrs with 10 wt % Alcoa A-14 alumina (as received)	68
Oil "A"	Agitated for 3 hrs with 10 wt % Alcoa A-14 alumina (activated at 260°C)	80
Oil "A"	Agitation for 16 hrs with 3 wt % General Chemical Co. C.P. alumina (as received)	1.5
Oil "A"	Agitation for 16 hrs with 10 wt % General Chemical Co. C.P. alumina (as received)	0.6
Oil "A"	Agitated for 3 hrs with 10 wt % Fisher C.P. anhydrous alumina (as received)	38
Oil "A"	Agitated for 3 hrs with 10 wt % Fisher C.P. anhydrous alumina (activated at 260°C)	62

Figure 4

Effect of adsorbents on Reduction of Oil "A" Corrosivity
Static Corrosion Test

Experimental Conditions	Lead Loss mg/in ²
Oil "A" as received	7.4
Oil "A" percolated through adsorption column:	
(1) Containing 10 g of activated chromatographic Al ₂ O ₃	0
a. Fraction 0 - 130 ml	0.4
b. Fraction 130 - 350 ml	7.3
c. Fraction 350 - 415 ml	0
(2) Containing 10 g of activated fuller's earth	0.8
a. Fraction 0 - 130 ml	5.0
b. Fraction 130 - 195 ml	
c. Fraction 195 - 260	
Oil "A" agitated with adsorbents:	
(1) With 2 wt % anhydrous Na ₂ CO ₃	7.8
(2) With 2 wt % activated fuller's earth	5.8
(3) With 2 wt % activated chromatographic Al ₂ O ₃	0.2